



India: Energy Demand and Supply and Climate Opportunities

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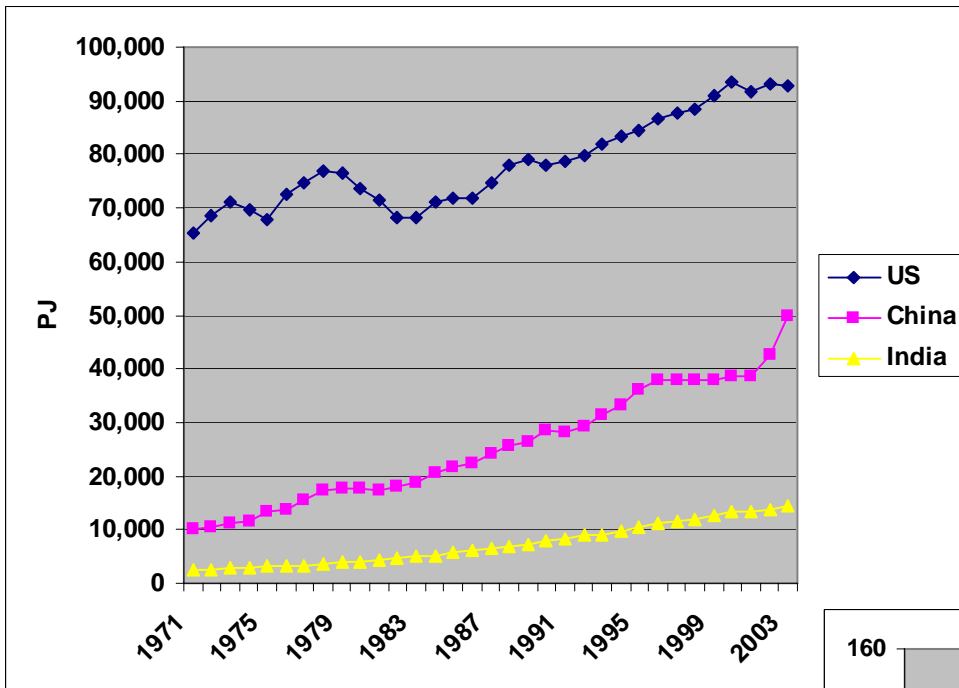
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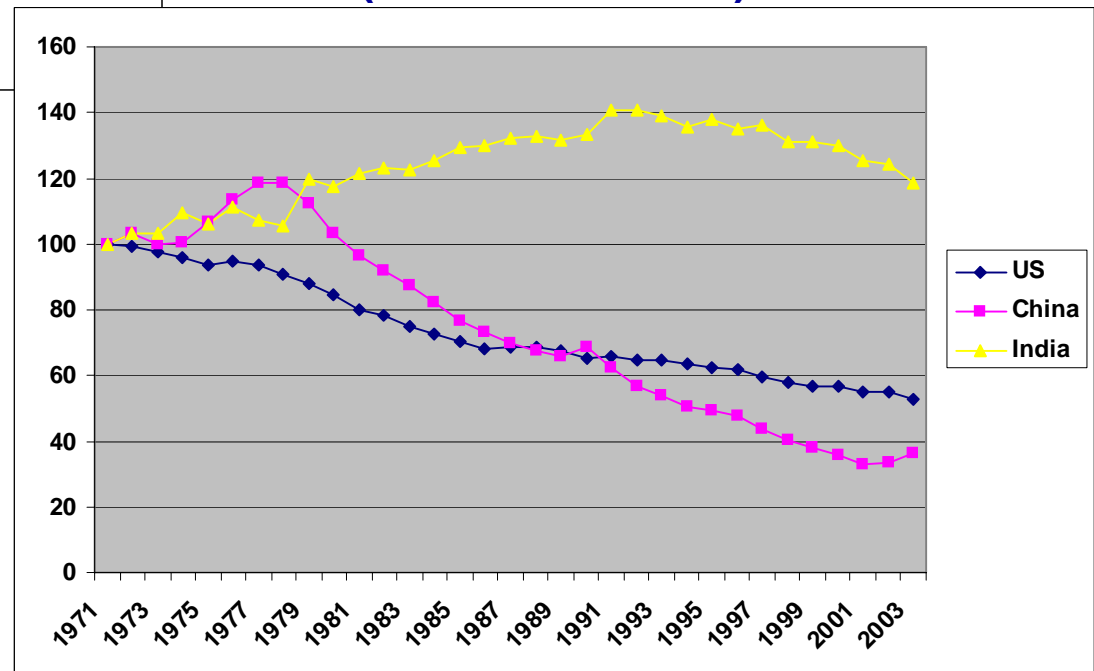


Energy situation in India: An Overview

Primary Energy Supply*



Primary Energy Supply* / GDP (Indexed to 1971)



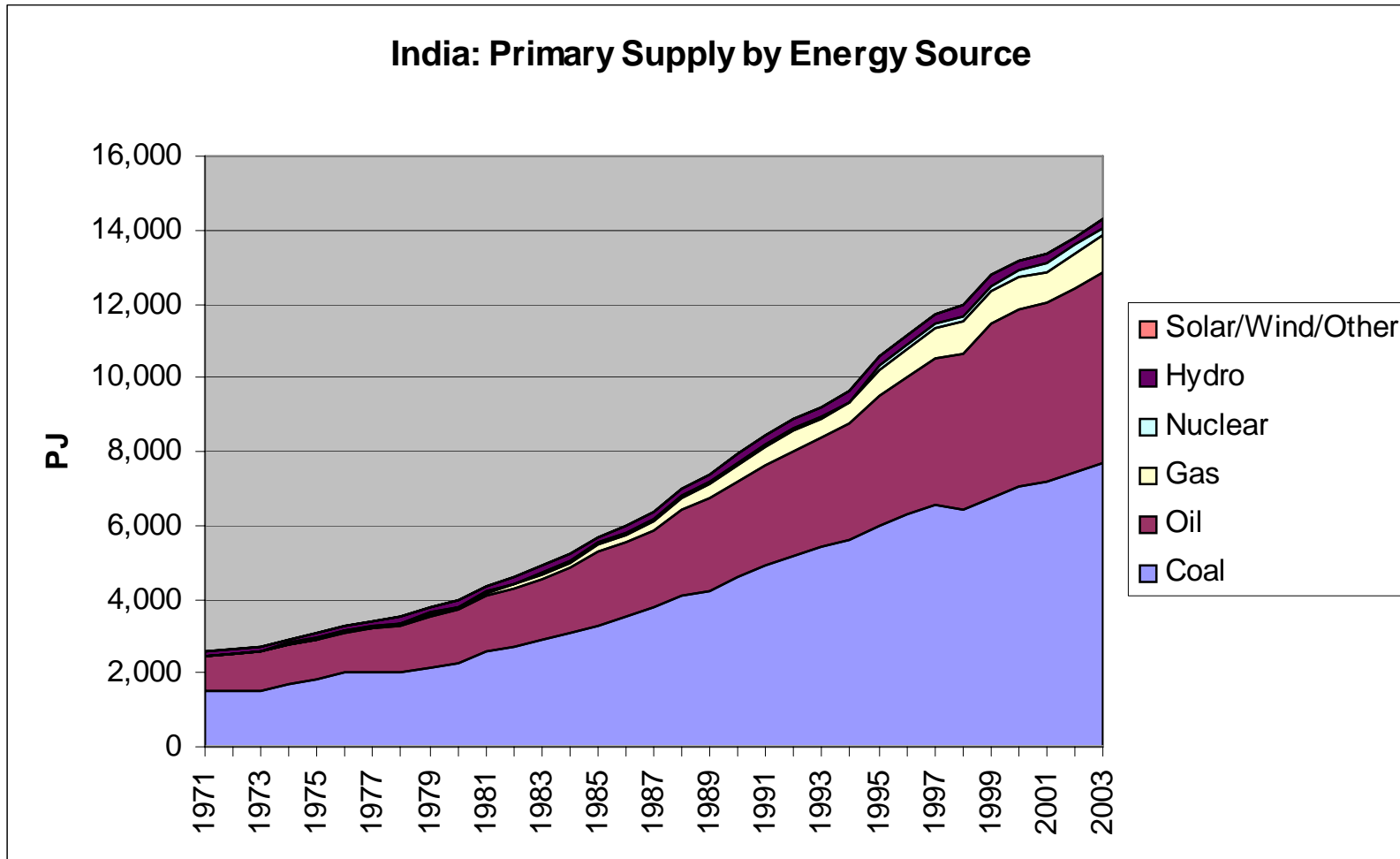
* Excl. traditional biomass in India

Source:

Energy data – IEA

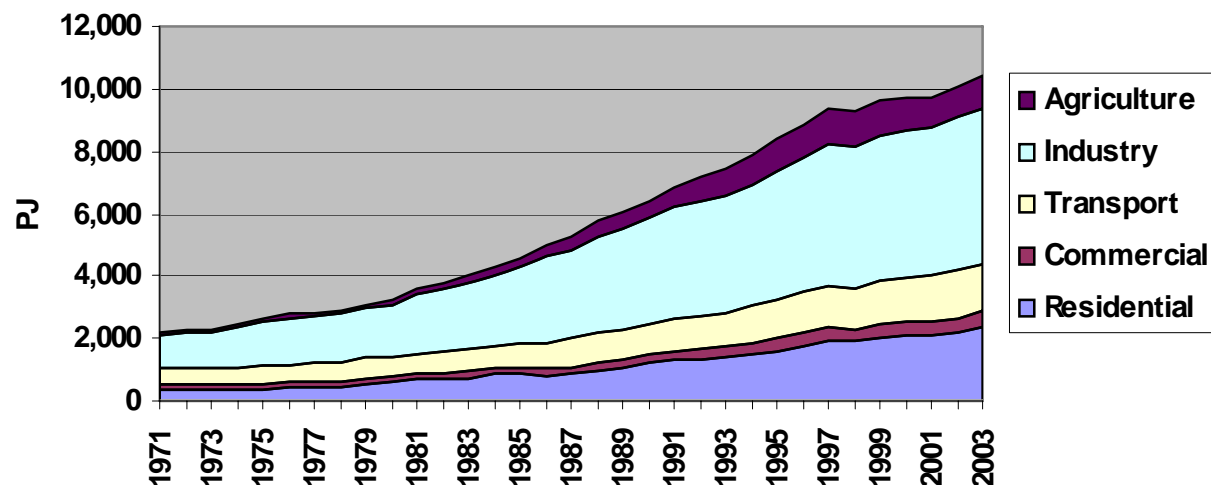
Economic data – World Bank

Coal continues to dominate energy mix, although natural gas share has increased

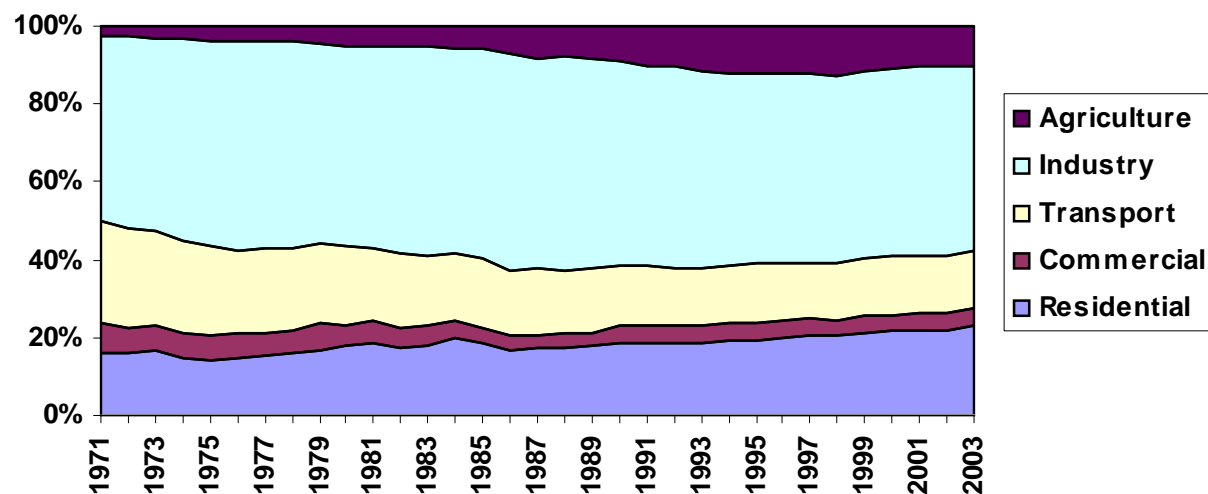


Source: Energy data – IEA

Primary Energy Consumption, India (Excl. traditional biomass)



Sectoral Shares



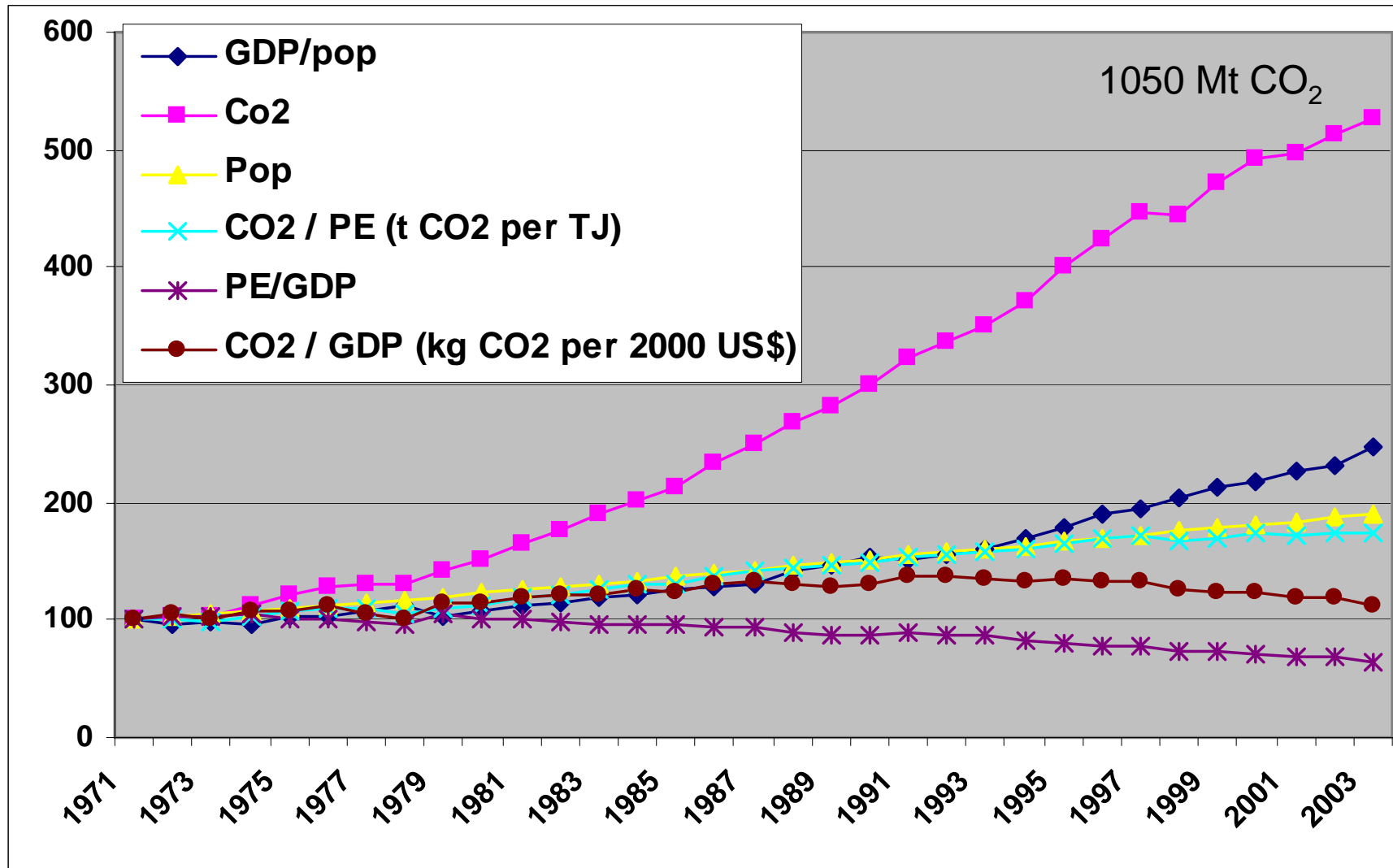
Increased Share of Agriculture and Residential and Commercial Energy Use:

- Electricity subsidized to both sectors
- 25% of state fiscal deficit in many states
- Subsidy is about \$2 billion annually

Source:

Energy data – IEA

Decomposing India CO₂ Emissions: Economic and population growth more than offset recent decline in CO₂ emissions intensity

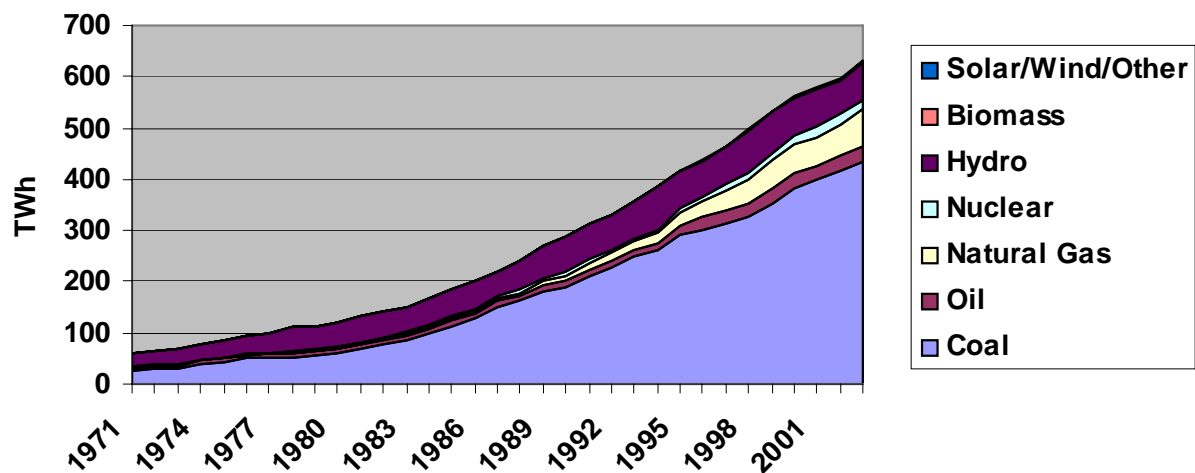


Source: Energy data – IEA; Economic data – World Bank

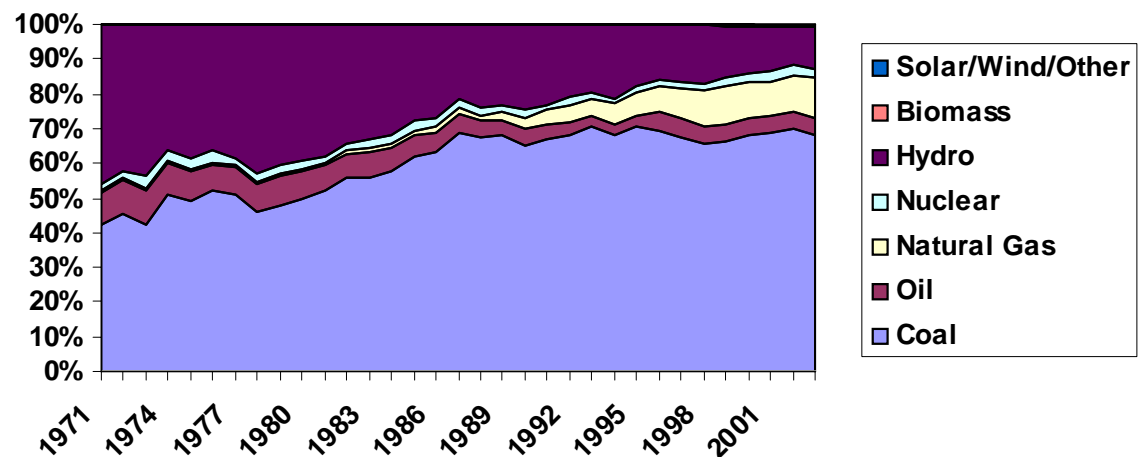


Electric Power Sector

Electricity Generation by Source



Shares



India	Generation Capacity (MW)	%
Total	123,668	100
Coal,	68,434	55.5
Natural gas	12,430	10.0
Oil	1,201	0.9
Hydro	32,135	26.0
Nuclear	3,310	2.7
Other	6,158	4.9

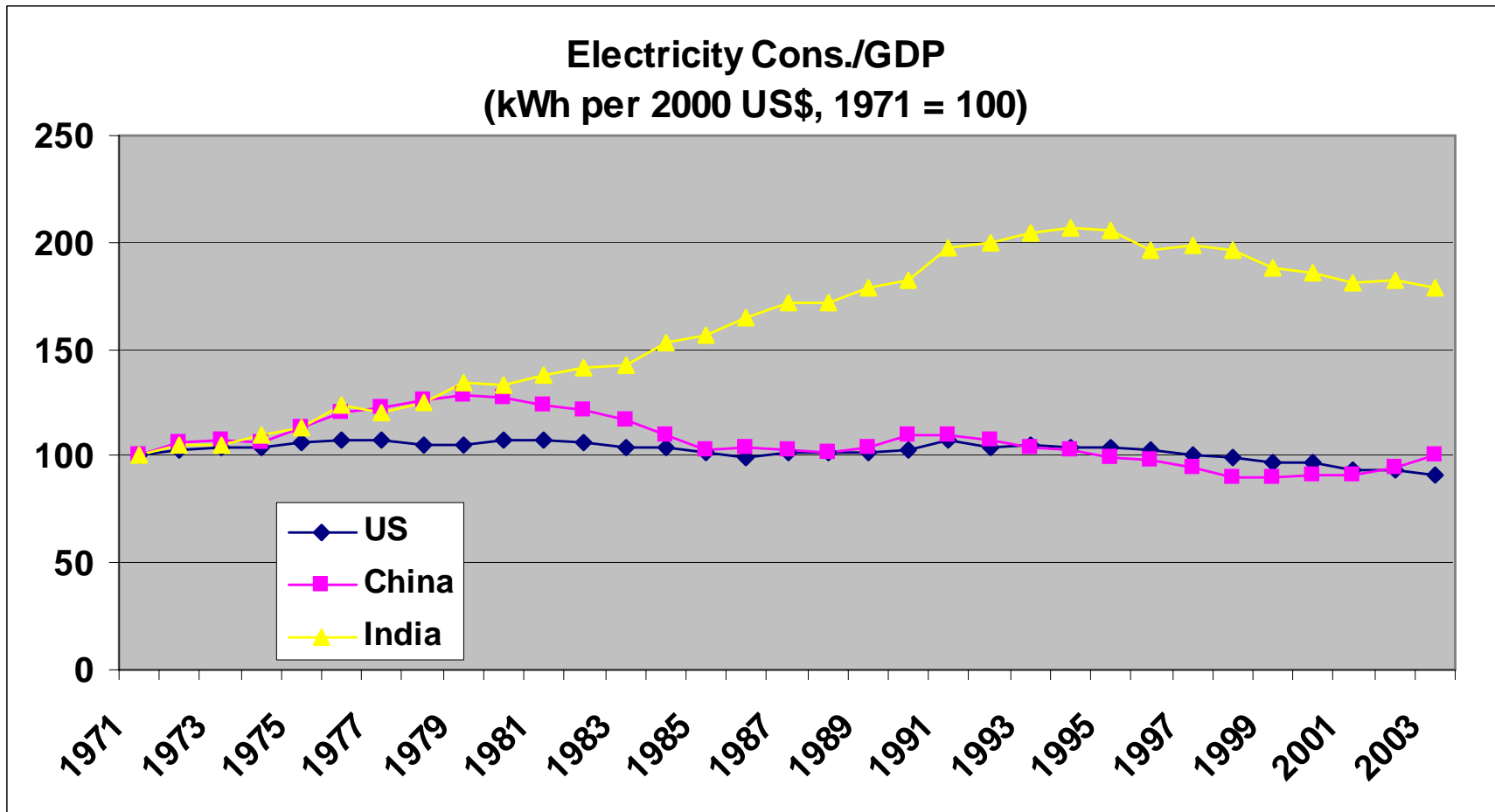
Source: IEA Energy Data, and Economic Survey, GOI, 2006

India Electricity Sector: Background Summary



- **Consumption per capita of 400 kWh in 2004-05, assuming 25% technical T&D loss; US consumption per capita – 13,000 kWh**
- **India sectoral consumption shares in 2004-05:**
 - Industrial – 35.6% -- Average tariff about 7 cents per kWh
 - Residential 24.8% -- Subsidized – average tariff about 6 cents/kWh
 - Commercial 8.1% -- Maximum tariff, about 9 cents per kWh
 - Agricultural – 22.9% -- Heavily subsidized – average tariff < 1 cent/kWh
- **Continued deficit supply in 2004-05:**
 - Peak power deficit 11.6%
 - Energy deficit 8 %
- **Severe transmission and distribution (T&D) loss**
 - About 50% in 2004-05 aggregate technical and commercial loss (AT&C)
 - Assuming 25% is technical loss -- 100 billion kWh or about \$6 billion a year
- **Five year plan targets have not been met:**
 - Against the 9th Plan (1997-'02) target of 40,245 MW new capacity, addition was about 21,000 MW
 - Private sector target: 17,589 MW vs. a realized addition of 6,735 MW
 - 10th plan (2002-'07) target 41,010 MW, revised down to 36,956 MW, commissioned: 13,416 MW
 - Deficits likely to continue in the near term

India's Electricity Intensity Declined Beginning in 1993

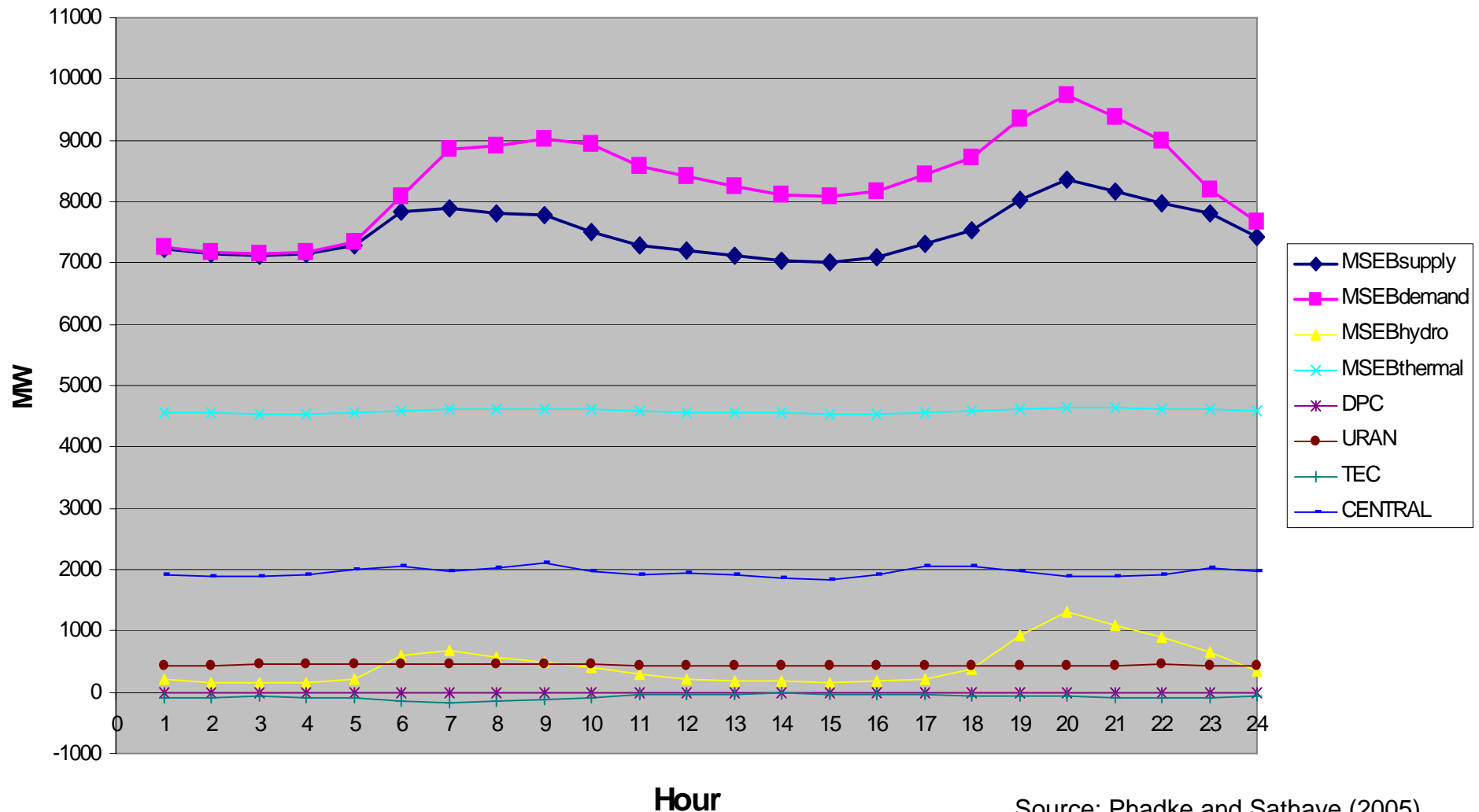


Source:

Energy data – IEA

Economic data – World Bank

Maharashtra State Electricity Board (MSEB) Capacity Deficit – Annual average (2002-03) (7836 GWh load shedding over 20 hours a day; 1376 MW average evening peak load shedding)



Source: Phadke and Sathaye (2005)

Electricity Efficiency Programs Can Play a Key Role

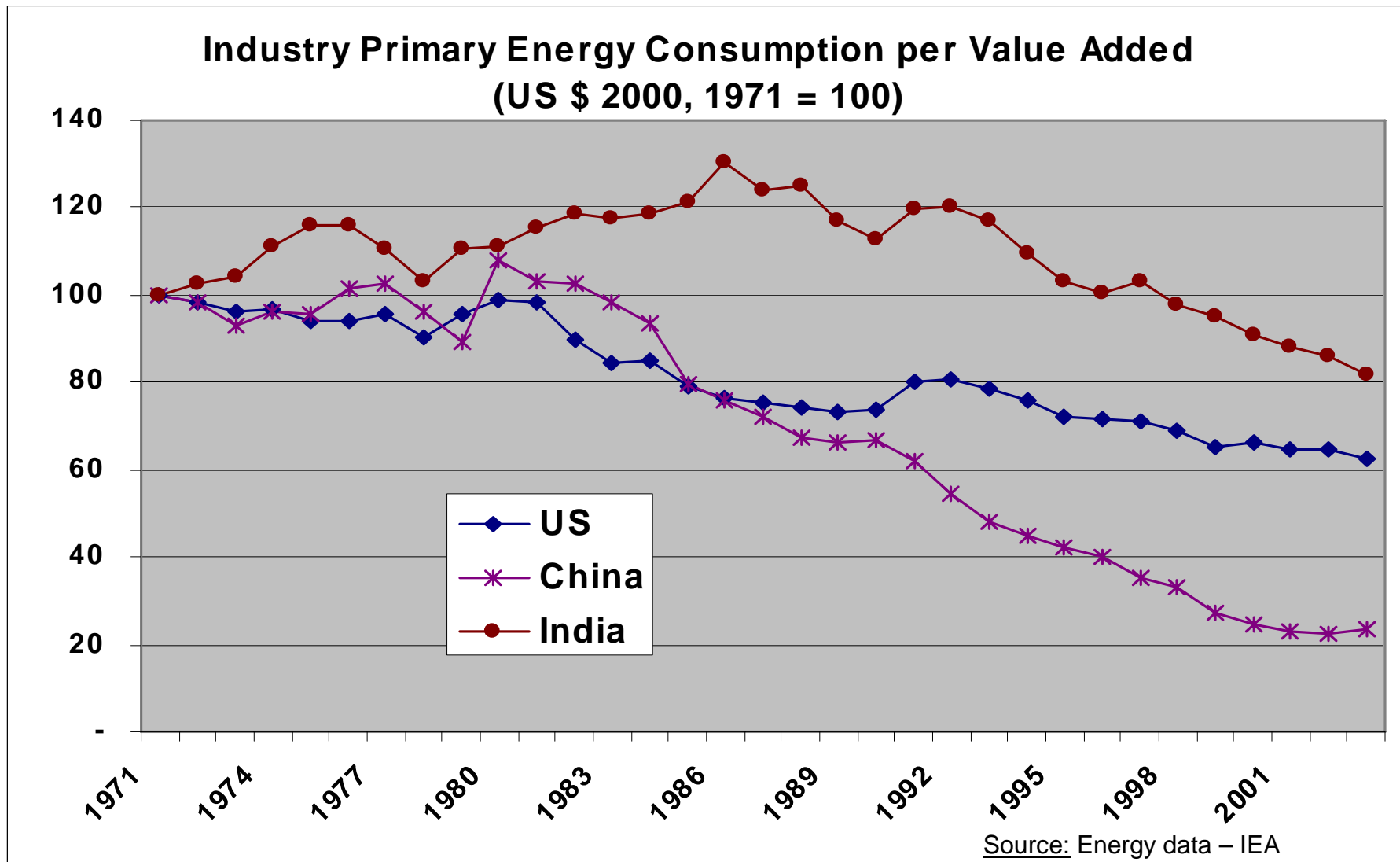


- **Indian states face several challenges —**
 - Growing electricity shortage, deteriorating utility finances, and fiscal deficits
- **Improving electricity efficiency through DSM programs for example can**
 - Reduce electricity shortage, a national potential of about 10,000 MW
 - Improve utility revenue and financial position
 - Reduce state government subsidy and increase sales tax revenue
 - 20 cents sales tax is lost for each kWh not delivered to businesses
 - Potential to eliminate between 15-25% of state fiscal deficit



Industrial Sector Energy efficiency

Continued improvement in India's industrial energy intensity since mid-1980s



Industrial Production: Aluminum, Cement and Steel

India is a Relatively Small Producer Except in the Case of Cement



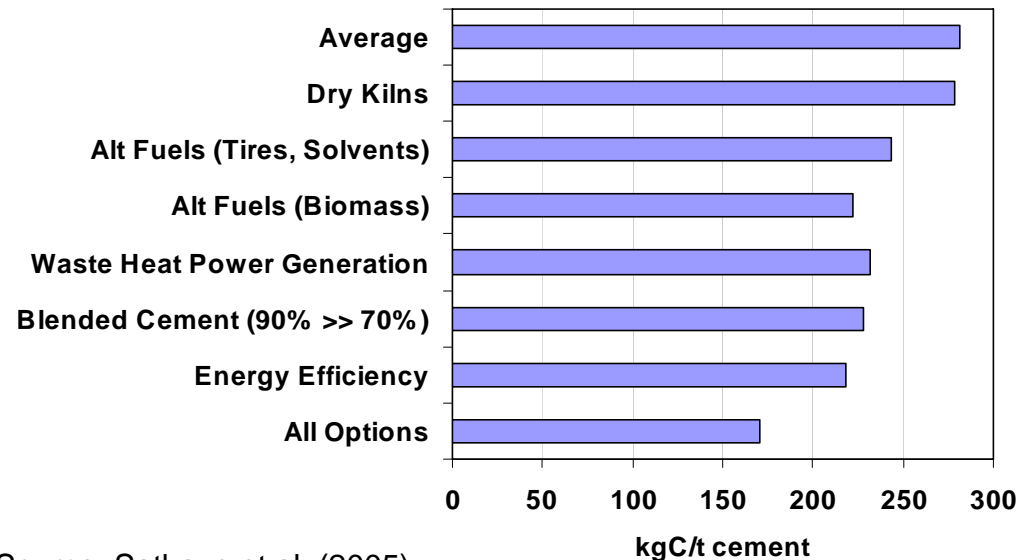
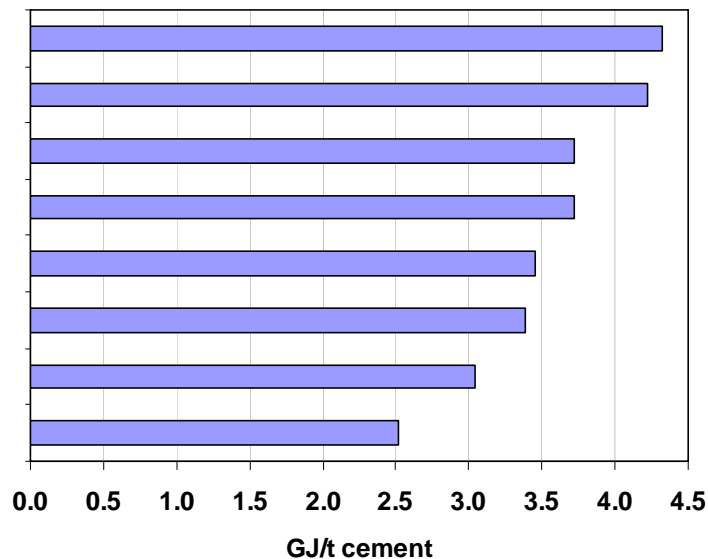
Country	Aluminum		Cement		Raw Steel	
	Thousand tonnes		Million tonnes		Million tonnes	
	2004		2005		2005	
China	6,670	22%	1,000	45%	333	31%
India	862	3%	130	6%	34	3%
US	2,516	8%	99.1	4%	92.4	8%
Other	19,752	66%	993	45%	631	58%
World Total	29,800	100%	2,222	100%	1,090	100%

Source: USGS, 2006

Energy Efficiency in the Indian Cement Industry

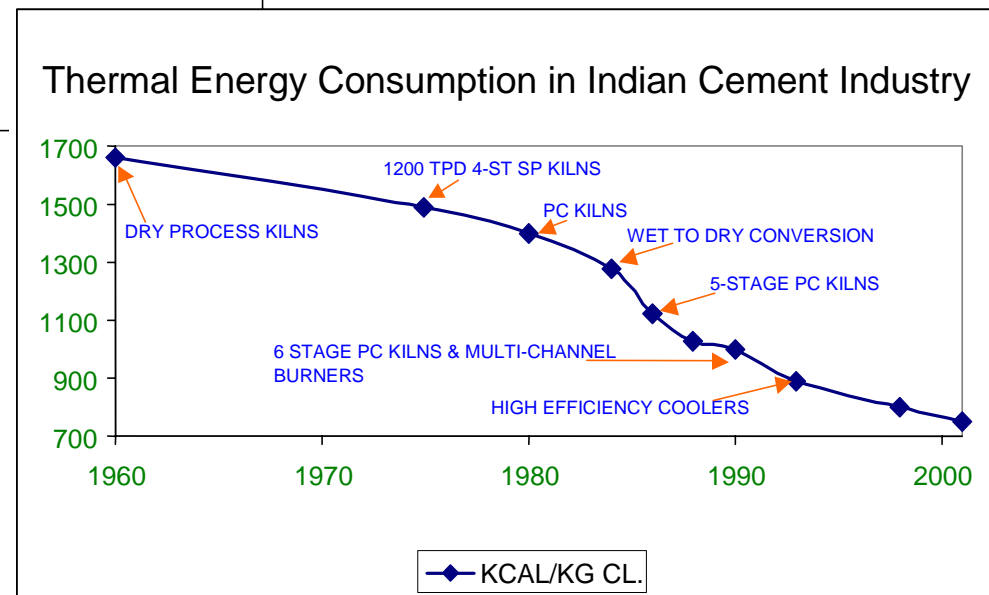
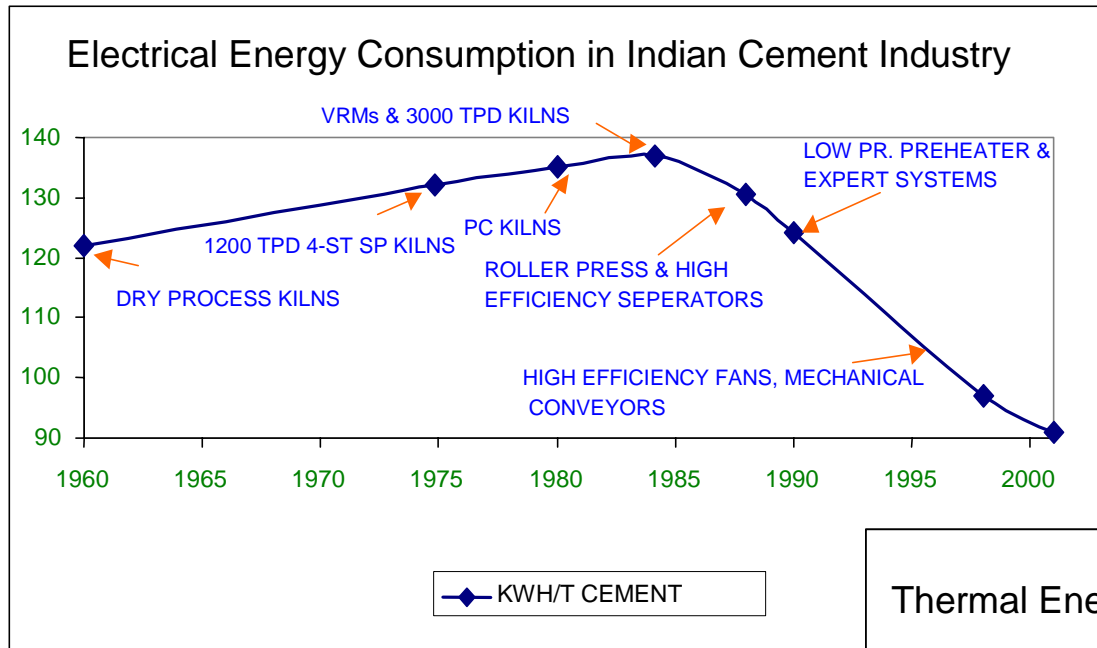


- Wide range in energy intensity in Indian cement industry
- Some of the most efficient plants in the world are in India
- Only 5% are inefficient wet kilns (vs. 18% in the U.S.)
- Energy savings and emission reduction possible through:
 - Improved energy efficiency
 - Increased blending of cement
 - Use of alternative fuels
 - Waste heat power generation



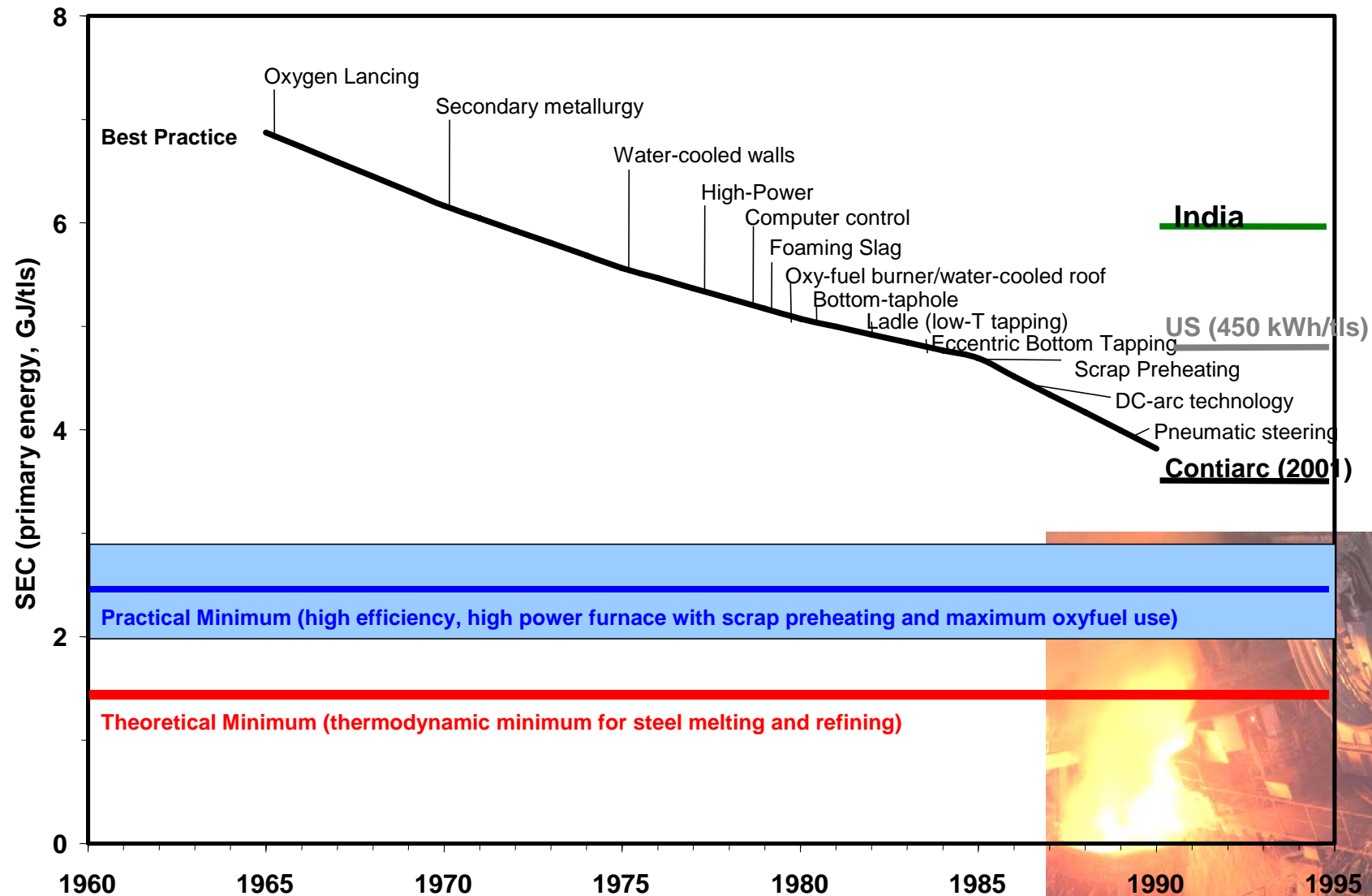
Source: Sathaye et al. (2005)

Cement Energy Intensity Trend, India



Source: Raina, 2002

Energy Efficiency in the Steel Industry – Electric Arc Furnace



Source: LBNL Estimate

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Estimated Energy Intensity Cement and Steel Production

Country	Cement	Steel
	(GJ / tonne cement)	(GJ / tonne cast steel)
China	5.7	23 -- 35
India	4.3	28 -- 32
US	5.4	20+ ? (MECS 94: 26)

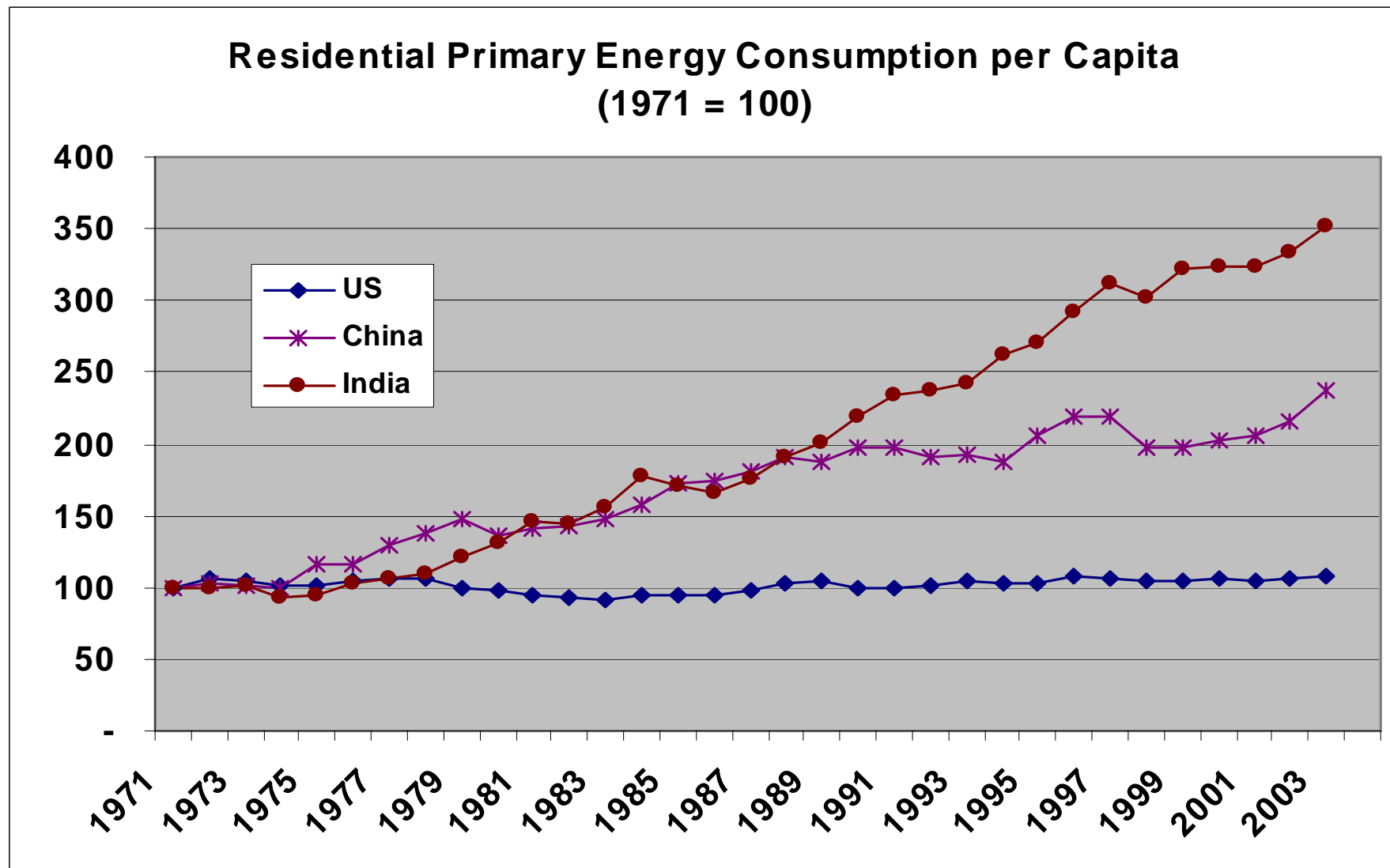
Source: LBNL Estimate based on analysis of the industries in each country

- Need better benchmarking of industrial energy use which will open opportunities for voluntary energy efficiency programs



Buildings and Appliances Energy Efficiency

Conversion to modern fuels adds to increase in India's household energy use per capita



Summary of Cost-Effective Unit Efficiency Potential for Four Products in India



Product	Base Case (kWh/year)	Efficiency Case (kWh/year)	Percentage Improvement
Refrigerator			
Direct-cool	381	208	45%
Room air conditioner			
Window	1191	1056	11%
Motors			
Agricultural – 5 HP	992*	875*	12%
Industrial – 15 HP	4079*	3264*	20%
Industrial – 20 HP	5562*	3387*	39%
Distribution transformer			
63 kVA	1834	797	57%
100 kVA	2619	1068	59%

Only Main Classes Shown

Source: McNeill et al. (2005)

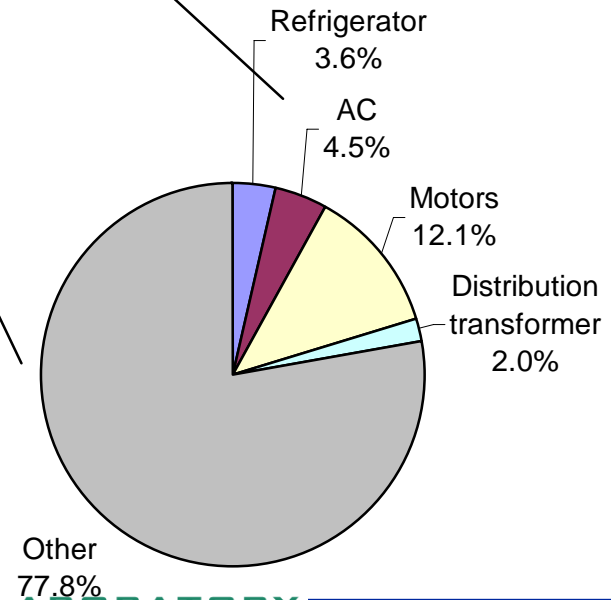
* Motor Consumption includes losses only.

Four-product Impact on Energy Efficiency in India in 2020



Product	Consumption		Potential savings	
	TWh	Percent	TWh	Percent
Refrigerators	45	3.6%	16.4	36.4%
Air Conditioners	56	4.5%	4.8	8.7%
Motors	151	12.1%	3.5	2.3%
Distribution transformers	25	2.0%	6.8	27.2%
<i>All 4 Products</i>	276	22.2%	31.5	11.4%
TOTAL India	1246	100.0%	31.5	2.5%

Source: McNeill et al. (2005)



Commercial Buildings



- Growing share of electricity use
- Several corporate buildings have been built to US Business Council's platinum and gold LEED ratings
- Government has stated goal for reducing its own consumption in major buildings
- Much of the sector still lags behind
- ESCOs could play a major role in the sector
 - Financing and risk sharing remain key issues



Energy efficiency: Key Institutions

India Energy Efficiency: Legislation, Institutions, Policies and Programs



- Federal institutions created in the 1970s and 1980s
 - Petroleum Conservation and Research Association (PCRA) under the Ministry of Petroleum and Natural Gas in 1978
 - National Productivity Council and the Energy Management Center
- Recent legislative mandates –
 - Energy Conservation Act 2001
 - Created the Bureau of Energy Efficiency (BEE) under the federal Ministry of Power to
 - Develop policies and strategies for reducing energy intensity
 - Delegate authority to state energy development agencies
 - Develop standards and labels for refrigerators, air conditioners, motors, agricultural pumps, and distribution transformers
 - Electricity Act 2003
 - Sets up central and state-level independent regulatory commissions similar to those in the US, can mandate and finance DSM programs
- Industry initiatives
 - Indian Green Business Center (GBC), Confederation of Indian Industry (CII)
 - Provides technical assistance and training to businesses

Conclusions

- Almost all approaches for improving energy efficiency are being tested and tried in India, and the liberalized markets offer more scope than in the past, still the pace is slow
 - Replication of successful practices and demonstrations is needed
- Low hanging fruit, always on the other side of fence,
 - Need best practices to find the gate and pathway
- Techno-economic analysis that is applied in a consistent framework is critical for assessing potential and transferring learning across countries
- Energy efficiency which is often perceived as a blue collar occupation needs to become a white-collar one –
 - Large scale financing of bundled projects where the risk may be shared



Thank you

Please check these websites for
LBNL India publications and activities and links

<http://ies.lbl.gov/iespubs/indiapubs.html>

<http://www.dc.lbl.gov/india/>

Publication site will be updated regularly over the next month

Rapid decline in service sector energy intensity due to fast growth in services value added



Services Primary Energy Consumption per value Added
(1971 = 100)

